Claims:

1. A catalyst system comprising the reaction product of:

    (a) an activator; and

    (b) a catalyst precursor comprising:

        (i) a Group-8, -9, or -10 transition metal, M;

        (ii) an ancillary ligand comprising:

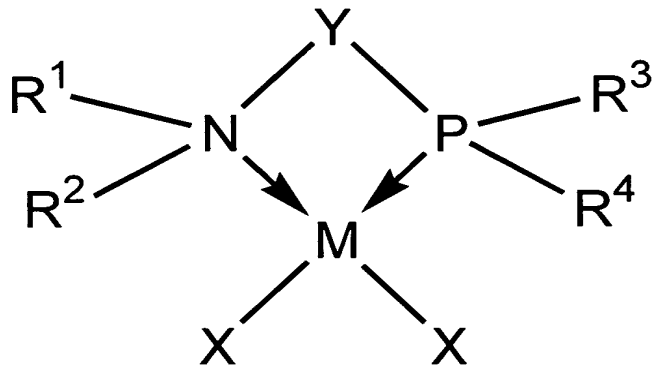
            - a terminal amine comprising two independently selected hydrocarbyl radicals, R^1 and R^2;

            - a terminal phosphine comprising two independently selected hydrocarbyl radicals, R^3 and R^4; and

            - a hydrocarbyl bridge, Y, comprising a backbone wherein the hydrocarbyl bridge connects between the terminal amine and the terminal phosphine and wherein the backbone comprises a chain that is four or more carbon atoms long; and

        (iii) an abstractable ligand, X.

2. The catalyst system of Claim 1 wherein the catalyst precursor has the following formula:



wherein

(i) M is a Group-8, -9, or -10 transition metal;

(ii) N is nitrogen;

(iii) P is phosphorus;

(iv) R^1, R^2, R^3, and R^4 are independently hydrocarbyl radicals;

(v) Y is a hydrocarbyl bridge comprising a backbone wherein the backbone comprises a chain that is four or more carbon atoms long;

(vi) X are independently abstractable ligands.

3. A catalyst system comprising the reaction product of

(a) the catalyst system of Claim 2 and

(b) ethylene, propylene, 1-butene, or a mixture of any two or all three of ethylene, propylene, and 1-butene.

4. The catalyst system of Claim 2 further comprising at least one additional olefin polymerization catalyst.

5. The catalyst system of Claim 2 wherein R^1, R^2, R^3, and R^4 are independently selected from C_1-C_{40} hydrocarbyls.

6. The catalyst system of Claim 5 wherein R^1, R^2, R^3, and R^4 are independently selected from C_1-C_{30} hydrocarbyls.

7. The catalyst system of Claim 6 wherein R^1, R^2, R^3, and R^4 are independently selected from methyl, ethyl, propyl, butyl, pentyl, hexyl, heptyl, octyl, nonyl, decyl, undecyl, dodecyl, tridecyl, tetradecyl, pentadecyl, hexadecyl, heptadecyl, octadecyl, nonadecyl, eicosyl, heneicosyl, docosyl, tricosyl, tetracosyl, pentacosyl, hexacosyl, heptacosyl, octacosyl, nonacosyl, triacontyl, ethenyl, propenyl, butenyl, pentenyl, hexenyl, heptenyl, octenyl, nonenyl, decenyl, undecenyl, dodecenyl, ethynyl, propynyl, butynyl, pentynyl, hexynyl, heptynyl, octynyl, nonynyl, decynyl, undecynyl, dodecynyl, phenyl, benzyl, phenethyl, tolyl, cyclobutyl, cyclopentyl, cyclohexyl, cycloheptyl, cyclooctyl, cyclononyl, cyclodecyl, cyclododecyl radicals.

8. The catalyst system of Claim 7 wherein R^1, R^2, R^3, and R^4 are independently selected from methyl, ethyl, propyl, butyl, cyclohexyl, phenyl, tolyl, benzyl, and phenethyl.

9. The catalyst system of Claim 2 wherein X are independently hydride radicals; hydrocarbyl radicals; hydrocarbyl-substituted, organometalloid radicals.

10. The catalyst system of Claim 9 wherein two X's are connected to form a 3-to-50-atom metallacycle ring.

11. The catalyst system of Claim 2 wherein X are independently halogen, alkoxide, aryloxide, amide, or phosphide radicals.

12. The catalyst system of Claim 11 wherein X are independently chloride, bromide, iodide, methoxide, ethoxide, dimethylamide, diethylethoxide, phenoxide.

13. The catalyst system of Claim 9 wherein X are independently methyl, ethyl, propyl, butyl, pentyl, hexyl, heptyl, octyl, nonyl, decyl, undecyl, dodecyl, tridecyl, tetradecyl, pentadecyl, hexadecyl, heptadecyl, octadecyl, nonadecyl, eicosyl, heneicosyl, docosyl, tricosyl, tetracosyl, pentacosyl, hexacosyl, heptacosyl, octacosyl, nonacosyl, triacontyl, hydride, phenyl, benzyl, phenethyl, tolyl, methoxy, ethoxy, propoxy, butoxy, dimethylamino, diethylamino, methylethylamino,

14. The catalyst system of Claim 2 wherein X are independently acetylacetonate, 1,1,1,5,5,5-hexa-fluoroacetylacetonate, 1,1,1-trifluoro-acetylacetonate, or 1,1,1-trifluoro-5,5-di-methylacetylacetonate radicals.

15. The catalyst system of Claim 2 wherein M is selected from nickel, iron, cobalt, palladium, platinum, ruthenium, osmium, rhodium, and iridium.

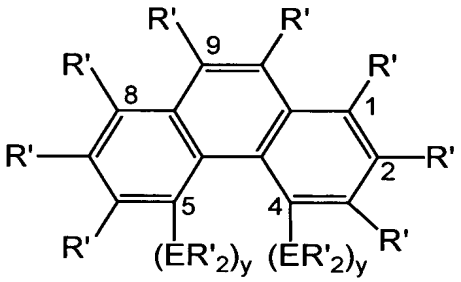
16. The catalyst system Claim 15 wherein M is selected from iron, nickel, cobalt, and palladium.

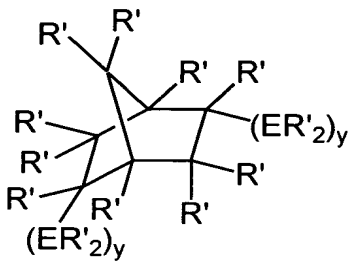
17. The catalyst system of Claim 15 wherein Y is selected from butylene, pentylene, hexylene, heptylene, octylene, nonylene, decylene, undecylene, dodecylene, tridecylene, tetradecylene, pentadecylene, hexadecylene, heptadecylene, octadecylene, nonadecylene, eicosylene, heneicosylene, docosylene, tricosylene, tetracosylene, pentacosylene, hexacosylene, heptacosylene, octacosylene, nonacosylene, triacontylene, cyclohexylene, cyclooctylene, cyclodecylene, cyclododecylene, biphenyl, butenylene, penentylene, hexenylene,

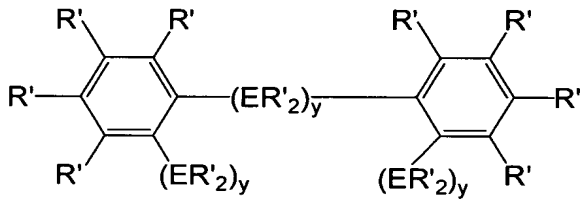
heptenylene, octenylene, nonenylene, decenylene, undecenylene, dodecenylene, hexynylene, heptynylene, octynylene, nonynylene, decynylene, undecynylene, dodecynylene, butadienylene, pentadienylene, hexadienylene, heptadienylene, octadienylene, nonadienylene, decadienylene, undecadienylene, dodecadienylene, hexatrienylene, octatrienylene, decatrienylene, and dodecatrienylene radicals.

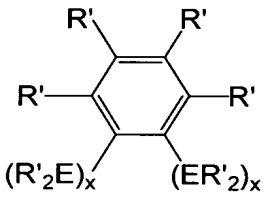
18. The catalyst system of 17 wherein Y is selected from biphenyl.

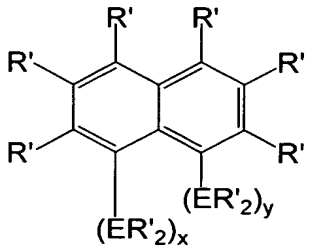
19. The catalyst system of 17 wherein Y has one of the following formulas:

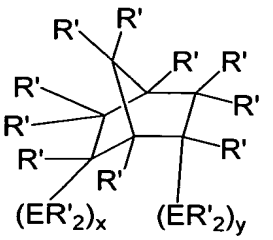


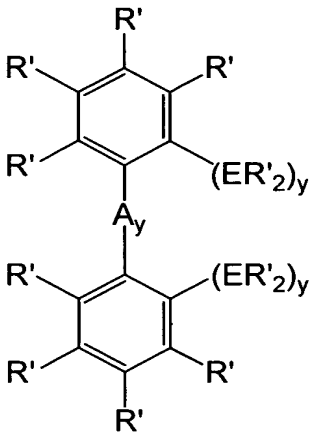


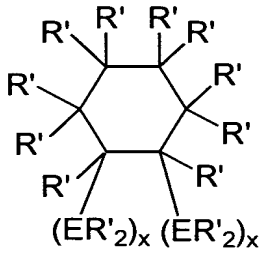


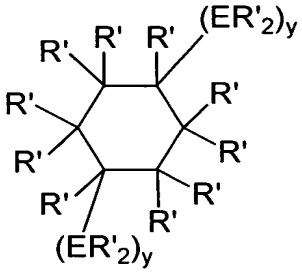


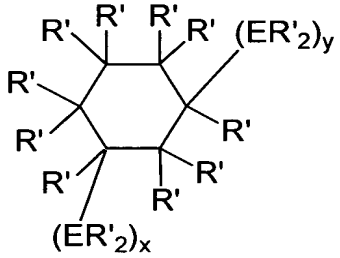


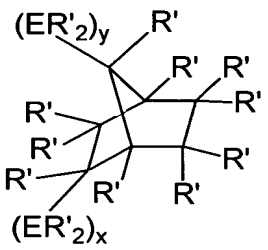


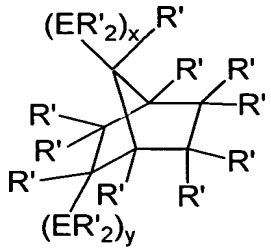


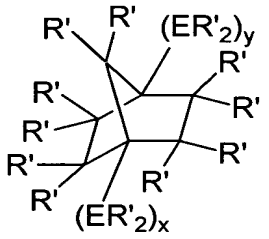


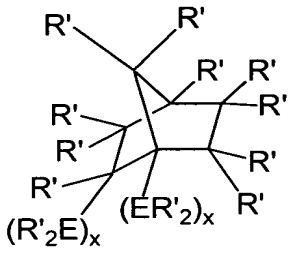


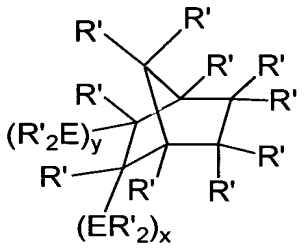


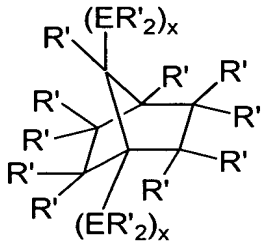


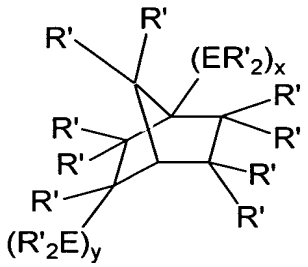


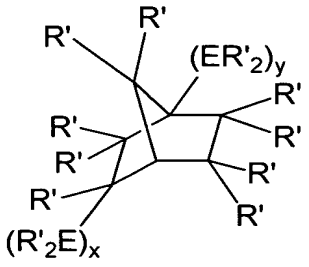












where

(a) R' are independently, hydrogen or C_1-C_{50} hydrocarbyl radicals;

(b) A is a non-hydrocarbon atom functional group;

(c) E is a Group-14 element;

(d) x is an integer from 1 to 4; and

(e) y is an integer from 0 to 4.

20. The catalyst system of Claim 19 wherein A is selected from C=O, C=S, O, S, SO_2, NR*, PR*, BR*, $SiR*_2$, and $GeR*_2$, where R* is independently a hydrocarbyl or halocarbyl radical.

21. A polymerization method comprising the step of providing at least one catalyst system of Claim 2.

22. The polymerization method of Claim 21 wherein the catalyst's activity exceeds 8000 moles of ethylene per mole transition metal per hour.

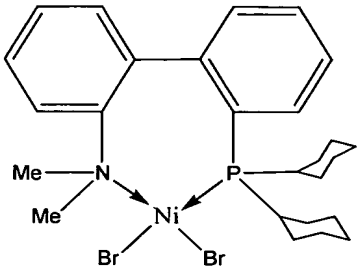
23. The polymerization method of Claim 22 further comprising recovering a product comprising greater than 50 mol% of linear C_4-C_{14} α-olefins based on the total weight of polymerized product.

24. The polymerization method of 23 wherein the product comprises greater than 80 mol% of linear C_4-C_{14} α-olefins.

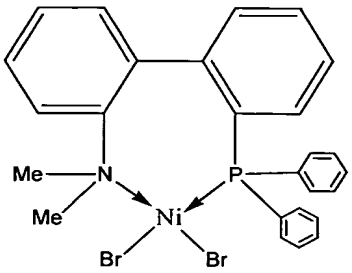
25. The polymerization method of 24 wherein the product comprises greater than 50 mol% of linear C_4 and C_6 α-olefins.

26. The polymerization method of 25 wherein the product comprises greater than 80 mol% of linear C_4 and C_6 α-olefins.

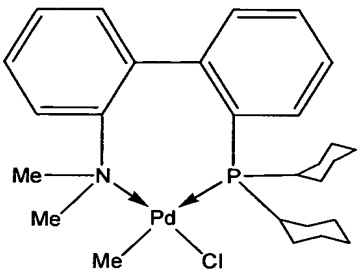
27. A catalyst precursor with one of the following formula:



Formula XX



Formula XXI

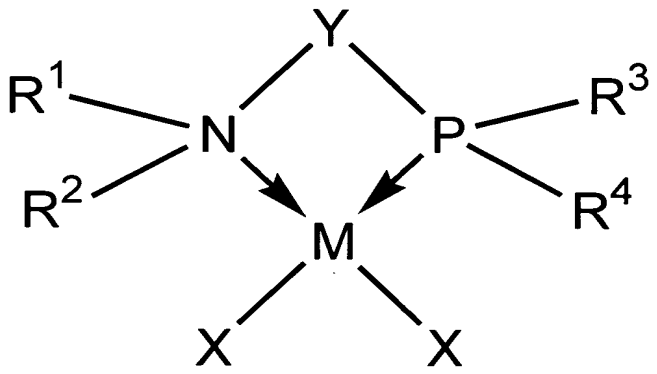


Formula XXIII

28. A catalyst system comprising the reaction product of:

(a) an activator; and

(b) a catalyst precursor with the following formula:



wherein

(i) M is iron, nickel, cobalt, and palladium;

(ii) N is nitrogen;

(iii) P is phosphorus;

(iv) R^1, R^2, R^3, and R^4 are independently selected from methyl, ethyl, propyl, butyl, pentyl, hexyl, heptyl, octyl, nonyl, decyl, undecyl, dodecyl, tridecyl, tetradecyl,

pentadecyl, hexadecyl, heptadecyl, octadecyl, nonadecyl, eicosyl, heneicosyl, docosyl, tricosyl, tetracosyl, pentacosyl, hexacosyl, heptacosyl, octacosyl, nonacosyl, triacontyl, ethenyl, propenyl, butenyl, pentenyl, hexenyl, heptenyl, octenyl, nonenyl, decenyl, undecenyl, dodecenyl, ethynyl, propynyl, butynyl, pentynyl, hexynyl, heptynyl, octynyl, nonynyl, decynyl, undecynyl, dodecynyl, phenyl, benzyl, phenethyl, tolyl, cyclobutyl, cyclopentyl, cyclohexyl, cycloheptyl, cyclooctyl, cyclononyl, cyclodecyl, cyclododecyl radicals;

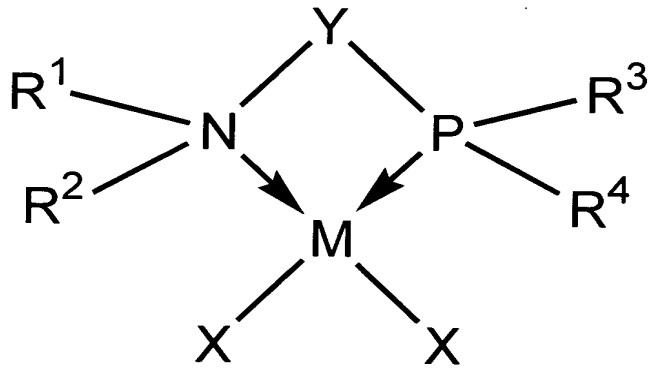
(v) Y is a hydrocarbyl bridge comprising a backbone wherein the backbone comprises a chain that is four or more carbon atoms long;

(vi) X are independently abstractable ligands.

29. A catalyst system comprising the reaction product of:

(a) an activator; and

(b) a catalyst precursor with the following formula:



wherein

(i) M is from nickel, iron, cobalt, palladium, platinum, ruthenium, osmium, rhodium, and iridium;

(ii) N is nitrogen;

(iii) P is phosphorus;

(iv) R^1, R^2, R^3, and R^4 are independently selected from methyl, ethyl, propyl, butyl, pentyl, hexyl, heptyl, octyl, nonyl, decyl, undecyl, dodecyl, tridecyl, tetradecyl, pentadecyl, hexadecyl, heptadecyl, octadecyl, nonadecyl, eicosyl, heneicosyl, docosyl, tricosyl, tetracosyl, pentacosyl, hexacosyl, heptacosyl, octacosyl, nonacosyl, triacontyl, ethenyl, propenyl, butenyl, pentenyl, hexenyl, heptenyl, octenyl, nonenyl, decenyl, undecenyl, dodecenyl, ethynyl, propynyl, butynyl, pentynyl, hexynyl, heptynyl, octynyl, nonynyl, decynyl, undecynyl, dodecynyl, phenyl, benzyl, phenethyl, tolyl, cyclobutyl, cyclopentyl, cyclohexyl, cycloheptyl, cyclooctyl, cyclononyl, cyclodecyl, cyclododecyl radicals;

(v) Y is a hydrocarbyl bridge comprising a backbone wherein the backbone comprises a chain that is four or more carbon atoms long; and

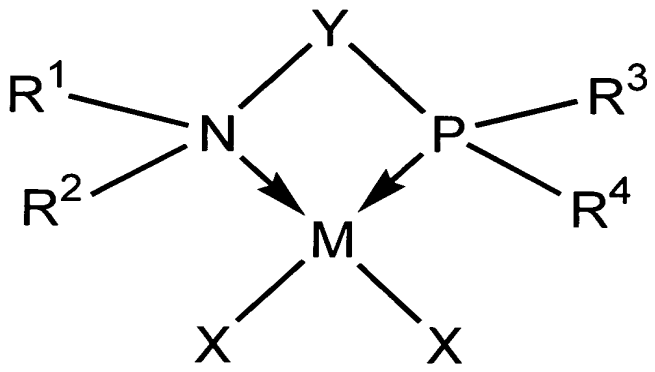
(vi) X are independently chloride, bromide, iodide, methoxide, ethoxide, dimethylamide, diethylethoxide, phenoxide, methyl, ethyl, propyl, butyl, pentyl, hexyl, heptyl, octyl, nonyl, decyl, undecyl, dodecyl, tridecyl, tetradecyl, pentadecyl, hexadecyl, heptadecyl, octadecyl, nonadecyl, eicosyl, heneicosyl, docosyl, tricosyl, tetracosyl, pentacosyl, hexacosyl, heptacosyl, octacosyl, nonacosyl, triacontyl, hydride, phenyl,

benzyl, phenethyl, tolyl, methoxy, ethoxy, propoxy, butoxy, dimethylamino, diethylamino, methylethylamino, acetylacetonate, 1,1,1,5,5,5-hexa-fluoroacetylacetonate, 1,1,1-trifluoro-acetylacetonate, or 1,1,1-trifluoro-5,5-di-methylacetylacetonate radicals; or two X's are connected to form a 3-to-40-atom metallacycle ring.

30. A catalyst system comprising the reaction product of:

(a) an activator; and

(b) a catalyst precursor with the following formula:



wherein

(i) M is from nickel, iron, cobalt, palladium, platinum, ruthenium, osmium, rhodium, and iridium;

(ii) N is nitrogen;

(iii) P is phosphorus;

(iv) R^1, R^2, R^3, and R^4 are independently selected from methyl, ethyl, propyl, butyl, pentyl, hexyl, heptyl, octyl,

nonyl, decyl, undecyl, dodecyl, tridecyl, tetradecyl, pentadecyl, hexadecyl, heptadecyl, octadecyl, nonadecyl, eicosyl, heneicosyl, docosyl, tricosyl, tetracosyl, pentacosyl, hexacosyl, heptacosyl, octacosyl, nonacosyl, triacontyl, ethenyl, propenyl, butenyl, pentenyl, hexenyl, heptenyl, octenyl, nonenyl, decenyl, undecenyl, dodecenyl, ethynyl, propynyl, butynyl, pentynyl, hexynyl, heptynyl, octynyl, nonynyl, decynyl, undecynyl, dodecynyl, phenyl, benzyl, phenethyl, tolyl, cyclobutyl, cyclopentyl, cyclohexyl, cycloheptyl, cyclooctyl, cyclononyl, cyclodecyl, cyclododecyl radicals;

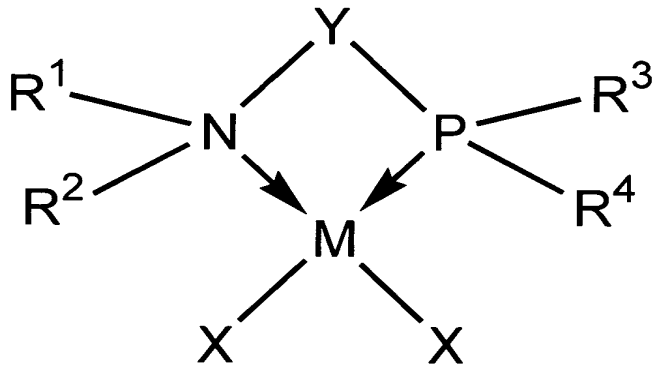
(v) Y is is selected from butylene, pentylene, hexylene, heptylene, octylene, nonylene, decylene, undecylene, dodecylene, tridecylene, tetradecylene, pentadecylene, hexadecylene, heptadecylene, octadecylene, nonadecylene, eicosylene, heneicosylene, docosylene, tricosylene, tetracosylene, pentacosylene, hexacosylene, heptacosylene, octacosylene, nonacosylene, triacontylene, cyclohexylene, cyclooctylene, cyclodecylene, cyclododecylene, biphenyl, butenylene, penentylene, hexenylene, heptenylene, octenylene, nonenylene, decenylene, undecenylene, dodecenylene, hexynylene, heptynylene, octynylene, nonynylene, decynylene, undecynylene, dodecynylene, butadienylene, pentadienylene, hexadienylene, heptadienylene, octadienylene, nonadienylene, decadienylene, undecadienylene, dodecadienylene, hexatrienylene, octatrienylene, decatrienylene, and dodecatrienylene radicals; and

(vi) X are independently chloride, bromide, iodide, methoxide, ethoxide, dimethylamide, diethylethoxide, phenoxide, methyl, ethyl, propyl, butyl, pentyl, hexyl, heptyl, octyl, nonyl, decyl, undecyl, dodecyl, tridecyl, tetradecyl, pentadecyl, hexadecyl, heptadecyl, octadecyl, nonadecyl, eicosyl, heneicosyl, docosyl, tricosyl, tetracosyl, pentacosyl, hexacosyl, heptacosyl, octacosyl, nonacosyl, triacontyl, hydride, phenyl, benzyl, phenethyl, tolyl, methoxy, ethoxy, propoxy, butoxy, dimethylamino, diethylamino, methylethylamino, acetylacetonate, 1,1,1,5,5,5-hexa-fluoroacetylacetonate, 1,1,1-trifluoro-acetylacetonate, or 1,1,1-trifluoro-5,5-di-methylacetylacetonate radicals; or two X's are connected to form a 3-to-40-atom metallacycle ring.

31. A catalyst system comprising the reaction product of:

(a) an activator; and

(b) a catalyst precursor with the following formula:



wherein

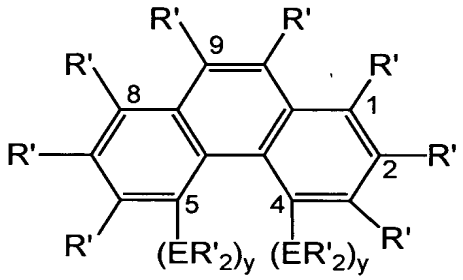
(i) M is a Group-8, -9, or -10 transition metal;

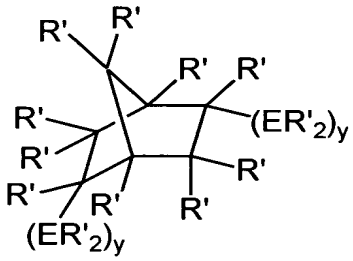
(ii) N is nitrogen;

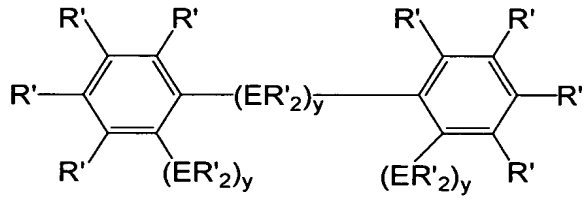
(iii) P is phosphorus;

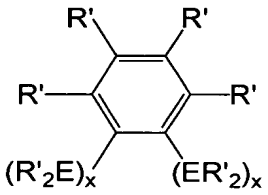
(iv) R^1, R^2, R^3, and R^4 R^1, R^2, R^3, and R^4 are independently hydrocarbyl radicals;

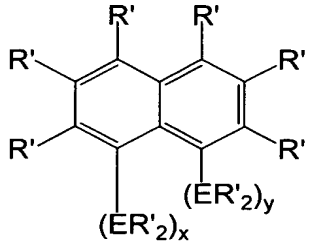
(v) Y is represented by one of the following formulas:

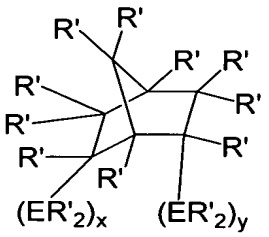


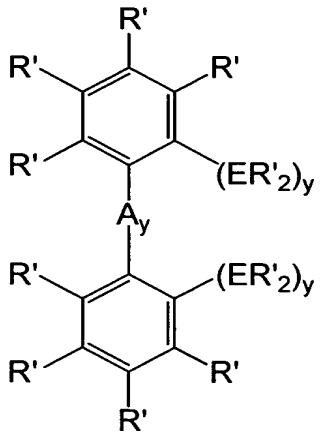


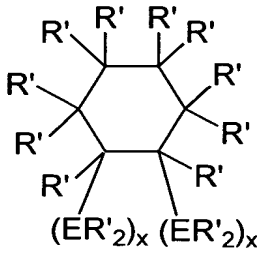


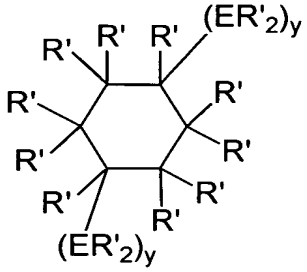


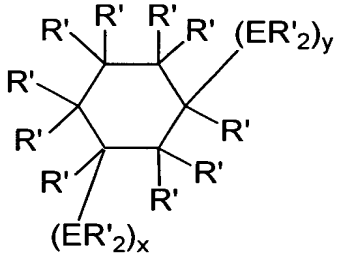


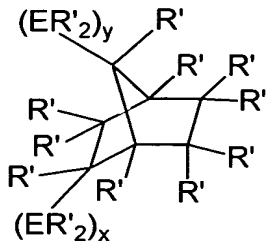


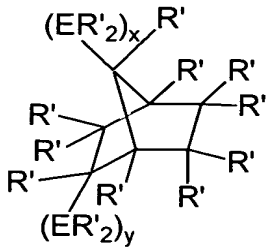


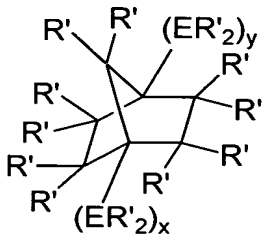


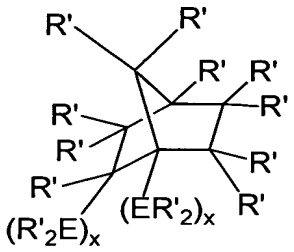


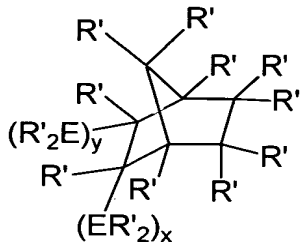


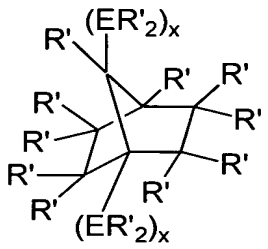


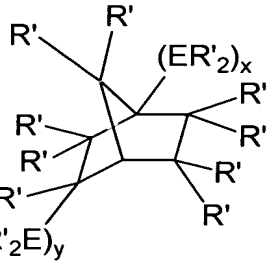


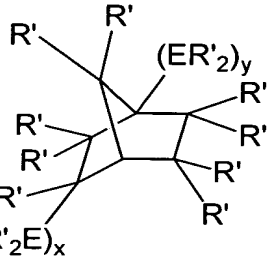












where

- R′ are independently, hydrogen or C_1-C_{50} hydrocarbyl radicals;

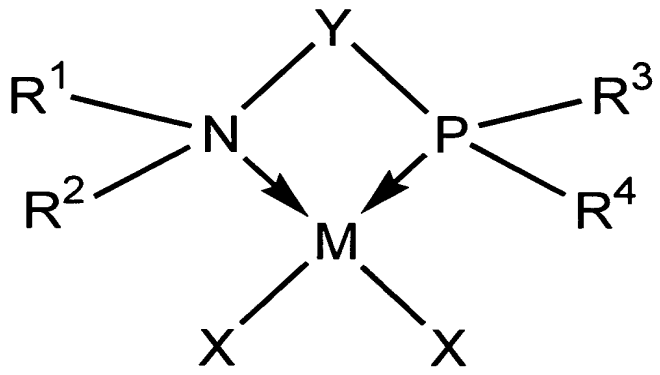
- A is a non-hydrocarbon atom functional group;
- E is a Group-14 element;
- x is an integer from 1 to 4; and
- y is an integer from 0 to 4.

(vi) X are independently chloride, bromide, iodide, methoxide, ethoxide, dimethylamide, diethylethoxide, phenoxide, methyl, ethyl, propyl, butyl, pentyl, hexyl, heptyl, octyl, nonyl, decyl, undecyl, dodecyl, tridecyl, tetradecyl, pentadecyl, hexadecyl, heptadecyl, octadecyl, nonadecyl, eicosyl, heneicosyl, docosyl, tricosyl, tetracosyl, pentacosyl, hexacosyl, heptacosyl, octacosyl, nonacosyl, triacontyl, hydride, phenyl, benzyl, phenethyl, tolyl, methoxy, ethoxy, propoxy, butoxy, dimethylamino, diethylamino, methylethylamino, acetylacetonate, 1,1,1,5,5,5-hexa-fluoroacetylacetonate, 1,1,1-trifluoro-acetylacetonate, or 1,1,1-trifluoro-5,5-di-methylacetylacetonate radicals; or two X's are connected to form a 3-to-40-atom metallacycle ring.

32. A polymerization method wherein the catalysts activity exceeds 8000 moles of ethylene per mole transition metal per hour comprising the step of providing at least one catalyst system comprising the reaction product of:

(a) an activator; and

(b) a catalyst precursor with the following formula:



wherein

(i) M is iron, nickel, cobalt, and palladium;

(ii) N is nitrogen;

(iii) P is phosphorus;

(iv) R^1, R^2, R^3, and R^4 are independently selected from methyl, ethyl, propyl, butyl, pentyl, hexyl, heptyl, octyl, nonyl, decyl, undecyl, dodecyl, tridecyl, tetradecyl, pentadecyl, hexadecyl, heptadecyl, octadecyl, nonadecyl, eicosyl, heneicosyl, docosyl, tricosyl, tetracosyl, pentacosyl, hexacosyl, heptacosyl, octacosyl, nonacosyl, triacontyl, ethenyl, propenyl, butenyl, pentenyl, hexenyl, heptenyl, octenyl, nonenyl, decenyl, undecenyl, dodecenyl, ethynyl, propynyl, butynyl, pentynyl, hexynyl, heptynyl, octynyl, nonynyl, decynyl, undecynyl, dodecynyl, phenyl, benzyl, phenethyl, tolyl, cyclobutyl, cyclopentyl, cyclohexyl, cycloheptyl, cyclooctyl, cyclononyl, cyclodecyl, cyclododecyl radicals;

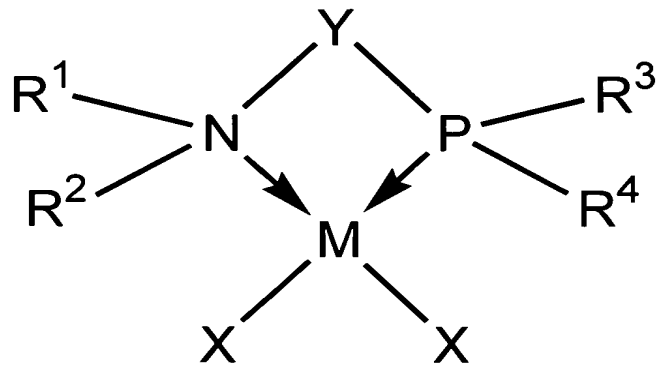
(v) Y is a hydrocarbyl bridge comprising a backbone wherein the backbone comprises a chain that is four or more carbon atoms long;

(vi) X are independently abstractable ligands.

33. A polymerization method wherein the catalysts activity exceeds 8000 moles of ethylene per mole transition metal per hour comprising the step of providing at least one catalyst system comprising the reaction product of:

(a) an activator; and

(b) a catalyst precursor with the following formula:



wherein

(i) M is from nickel, iron, cobalt, palladium, platinum, ruthenium, osmium, rhodium, and iridium;

(ii) N is nitrogen;

(iii) P is phosphorus;

(iv) R^1, R^2, R^3, and R^4 are independently selected from methyl, ethyl, propyl, butyl, pentyl, hexyl, heptyl, octyl, nonyl, decyl, undecyl, dodecyl, tridecyl, tetradecyl, pentadecyl, hexadecyl, heptadecyl, octadecyl, nonadecyl, eicosyl, heneicosyl, docosyl, tricosyl, tetracosyl, pentacosyl,

hexacosyl, heptacosyl, octacosyl, nonacosyl, triacontyl, ethenyl, propenyl, butenyl, pentenyl, hexenyl, heptenyl, octenyl, nonenyl, decenyl, undecenyl, dodecenyl, ethynyl, propynyl, butynyl, pentynyl, hexynyl, heptynyl, octynyl, nonynyl, decynyl, undecynyl, dodecynyl, phenyl, benzyl, phenethyl, tolyl, cyclobutyl, cyclopentyl, cyclohexyl, cycloheptyl, cyclooctyl, cyclononyl, cyclodecyl, cyclododecyl radicals;

(v) Y is a hydrocarbyl bridge comprising a backbone wherein the backbone comprises a chain that is four or more carbon atoms long; and

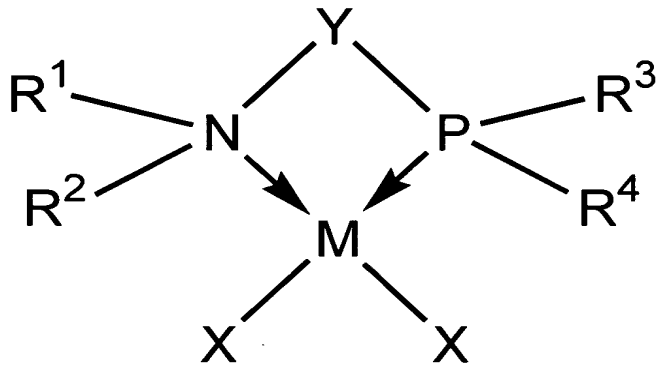
(vi) X are independently chloride, bromide, iodide, methoxide, ethoxide, dimethylamide, diethylethoxide, phenoxide, methyl, ethyl, propyl, butyl, pentyl, hexyl, heptyl, octyl, nonyl, decyl, undecyl, dodecyl, tridecyl, tetradecyl, pentadecyl, hexadecyl, heptadecyl, octadecyl, nonadecyl, eicosyl, heneicosyl, docosyl, tricosyl, tetracosyl, pentacosyl, hexacosyl, heptacosyl, octacosyl, nonacosyl, triacontyl, hydride, phenyl, benzyl, phenethyl, tolyl, methoxy, ethoxy, propoxy, butoxy, dimethylamino, diethylamino, methylethylamino, acetylacetonate, 1,1,1,5,5,5-hexa-fluoroacetylacetonate, 1,1,1-trifluoro-acetylacetonate, or 1,1,1-trifluoro-5,5-di-methylacetylacetonate radicals; or two X's are connected to form a 3-to-40-atom metallacycle ring.

34. A polymerization method wherein the catalysts activity exceeds 8000 moles of ethylene per mole transition metal per hour comprising the

step of providing at least one catalyst system comprising the reaction product of:

(a) an activator; and

(b) a catalyst precursor with the following formula:



wherein

(i) M is from nickel, iron, cobalt, palladium, platinum, ruthenium, osmium, rhodium, and iridium;

(ii) N is nitrogen;

(iii) P is phosphorus;

(iv) R^1, R^2, R^3, and R^4 are independently selected from methyl, ethyl, propyl, butyl, pentyl, hexyl, heptyl, octyl, nonyl, decyl, undecyl, dodecyl, tridecyl, tetradecyl, pentadecyl, hexadecyl, heptadecyl, octadecyl, nonadecyl, eicosyl, heneicosyl, docosyl, tricosyl, tetracosyl, pentacosyl, hexacosyl, heptacosyl, octacosyl, nonacosyl, triacontyl, ethenyl, propenyl, butenyl, pentenyl, hexenyl, heptenyl, octenyl, nonenyl, decenyl, undecenyl, dodecenyl, ethynyl, propynyl, butynyl, pentynyl, hexynyl, heptynyl, octynyl,

nonynyl, decynyl, undecynyl, dodecynyl, phenyl, benzyl, phenethyl, tolyl, cyclobutyl, cyclopentyl, cyclohexyl, cycloheptyl, cyclooctyl, cyclononyl, cyclodecyl, cyclododecyl radicals;

(v) Y is is selected from butylene, pentylene, hexylene, heptylene, octylene, nonylene, decylene, undecylene, dodecylene, tridecylene, tetradecylene, pentadecylene, hexadecylene, heptadecylene, octadecylene, nonadecylene, eicosylene, heneicosylene, docosylene, tricosylene, tetracosylene, pentacosylene, hexacosylene, heptacosylene, octacosylene, nonacosylene, triacontylene, cyclohexylene, cyclooctylene, cyclodecylene, cyclododecylene, biphenyl, butenylene, penentylene, hexenylene, heptenylene, octenylene, nonenylene, decenylene, undecenylene, dodecenylene, hexynylene, heptynylene, octynylene, nonynylene, decynylene, undecynylene, dodecynylene, butadienylene, pentadienylene, hexadienylene, heptadienylene, octadienylene, nonadienylene, decadienylene, undecadienylene, dodecadienylene, hexatrienylene, octatrienylene, decatrienylene, and dodecatrienylene radicals; and

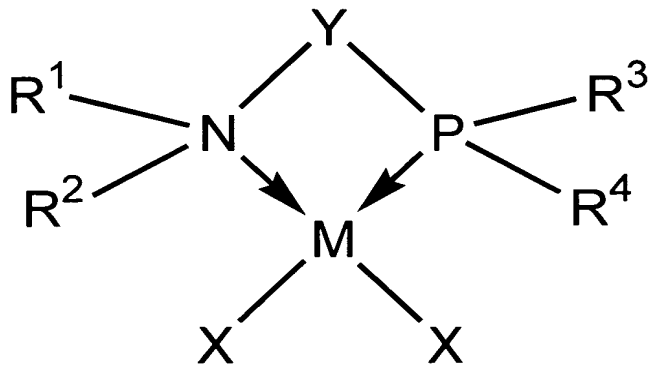
(vi) X are independently chloride, bromide, iodide, methoxide, ethoxide, dimethylamide, diethylethoxide, phenoxide, methyl, ethyl, propyl, butyl, pentyl, hexyl, heptyl, octyl, nonyl, decyl, undecyl, dodecyl, tridecyl, tetradecyl, pentadecyl, hexadecyl, heptadecyl, octadecyl, nonadecyl, eicosyl, heneicosyl, docosyl,

tricosyl, tetracosyl, pentacosyl, hexacosyl, heptacosyl, octacosyl, nonacosyl, triacontyl, hydride, phenyl, benzyl, phenethyl, tolyl, methoxy, ethoxy, propoxy, butoxy, dimethylamino, diethylamino, methylethylamino, acetylacetonate, 1,1,1,5,5,5-hexa-fluoroacetylacetonate, 1,1,1-trifluoro-acetylacetonate, or 1,1,1-trifluoro-5,5-di-methylacetylacetonate radicals; or two X's are connected to form a 3-to-40-atom metallacycle ring.

35. A polymerization method wherein the catalysts activity exceeds 8000 moles of ethylene per mole transition metal per hour comprising the step of providing at least one catalyst system comprising the reaction product of:

(a) an activator; and

(b) a catalyst precursor with the following formula:



wherein

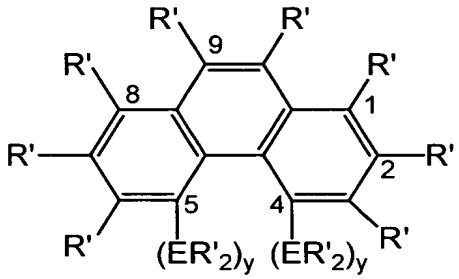
(i) M is a Group-8, -9, or -10 transition metal;

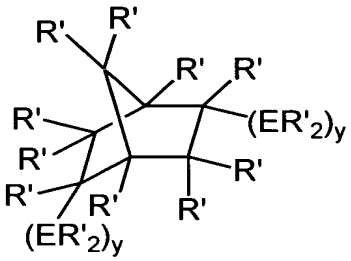
(ii) N is nitrogen;

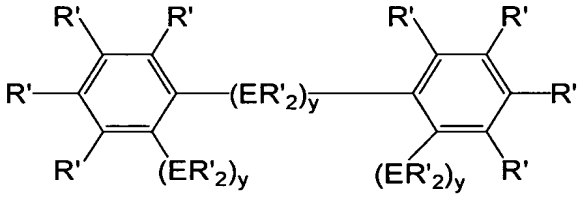
(iii) P is phosphorus;

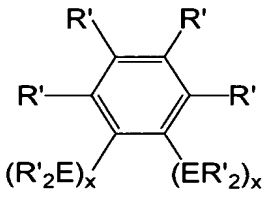
(iv) R^1, R^2, R^3, and R^4 R^1, R^2, R^3, and R^4 are independently hydrocarbyl radicals;

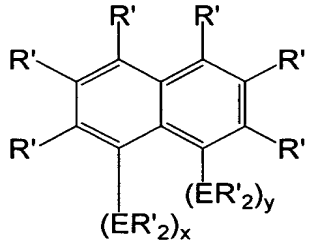
(v) Y is represented by one of the following formulas:

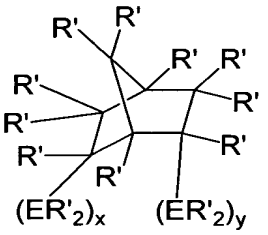


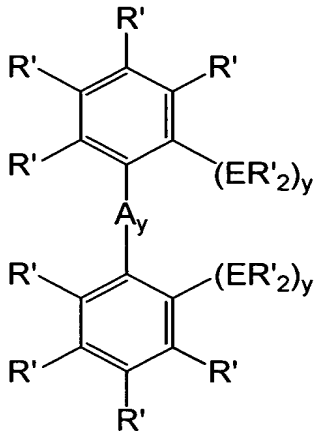


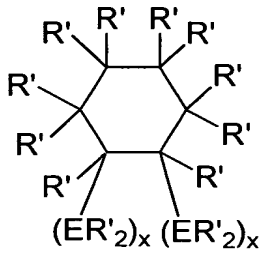


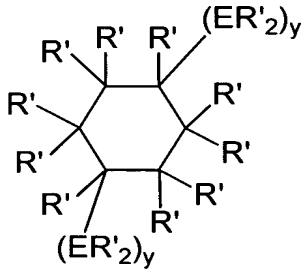


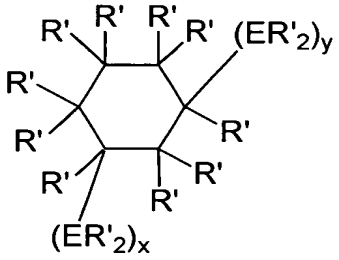


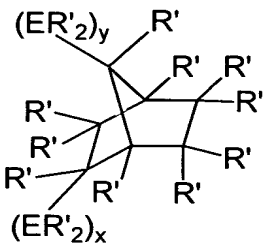


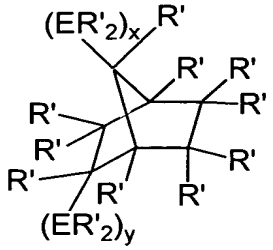


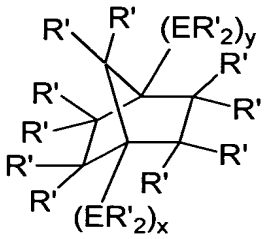


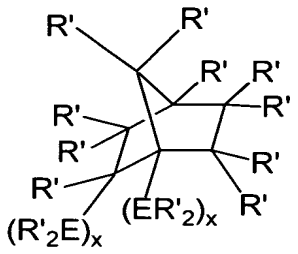


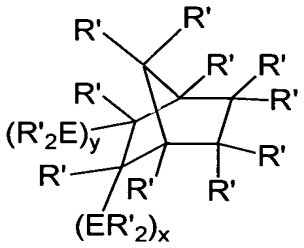


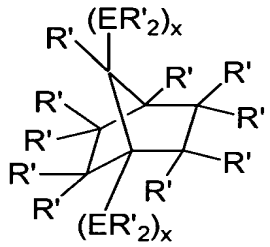


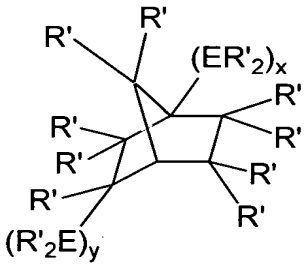


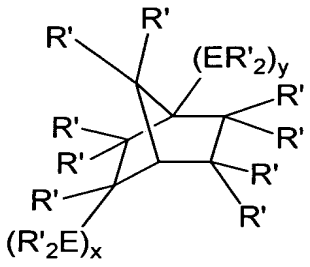












where

- R′ are independently, hydrogen or C_1-C_{50} hydrocarbyl radicals;

- A is a non-hydrocarbon atom functional group;
- E is a Group-14 element;
- x is an integer from 1 to 4; and
- y is an integer from 0 to 4.

(vi) X are independently chloride, bromide, iodide, methoxide, ethoxide, dimethylamide, diethylethoxide, phenoxide, methyl, ethyl, propyl, butyl, pentyl, hexyl, heptyl, octyl, nonyl, decyl, undecyl, dodecyl, tridecyl, tetradecyl, pentadecyl, hexadecyl, heptadecyl, octadecyl, nonadecyl, eicosyl, heneicosyl, docosyl, tricosyl, tetracosyl, pentacosyl, hexacosyl, heptacosyl, octacosyl, nonacosyl, triacontyl, hydride, phenyl, benzyl, phenethyl, tolyl, methoxy, ethoxy, propoxy, butoxy, dimethylamino, diethylamino, methylethylamino, acetylacetonate, 1,1,1,5,5,5-hexa-fluoroacetylacetonate, 1,1,1-trifluoro-acetylacetonate, or 1,1,1-trifluoro-5,5-di-methylacetylacetonate radicals; or two X's are connected to form a 3-to-40-atom metallacycle ring.